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Semiannual Report

August 93-April 1994

High Tc Superconducting Bolometric and Nonbolometric Infrared (IR) Detectors

NASA GRANT# NAG 5-2348

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Unclass

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(NASA-CR-195728) HIGH Tc
SUPERCONDUCTING BOLOMETRIC AND
NONBOLOMETRIC INFRARED (IR)
DETECTORS Semiannual Report, Aug-
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STATUS REPORT

ATTACHMENTS:

Abstracts

Course Description

Applied Superconductivity Laboratory (pictures)

STATUS REPORT

I. Original workplan: brief summary

The original workplan for the first year of the project includes the following:

- a. Establishment of a pilot superconductivity application laboratory at UDC to support the research component of the project ;
- b. Research on the source of electrical noise in High T_c superconducting films in order to optimize the film micro structure and lower the NEP; and
- c. Lay the foundation of an academic support for exposing UDC students to the theory and application of High T_c superconductivity.

II. Pilot Superconductivity laboratory at UDC

The pilot Applied Superconductivity Laboratory at the Department of Electrical Engineering at UDC is nearly functional. The electrical transport measurement system for resistivity, critical current density and I-V measurements has been set up for operation in the temperature range 4K-300K. The measurements are fully automated using the LABVIEW for Windows interface for controlling all GPIB compatible instruments in the laboratory.

In addition, the laboratory serves to initiate senior Electrical Engineering students in the conduct of applied research work. To date, three students, including the research assistant, have been working in the laboratory as part as their Senior Project assignments. So far the following tasks have been completed:

1. Setup and calibration of the various measurements including the cryogenic system;
2. LABVIEW program development for fully automating GPIB compatible instruments; and
3. LABVIEW program development for signal acquisition and noise estimation (i.e. Power Spectrum calculation)

III. Research in Collaboration with the Center for Superconductivity Research (CSR) at the University of Maryland

1. Electrical Noise measurements

We have set up a measurement system at the CSR for the study of electrical noise in superconducting thin films. This work is conducted by the research associate of the

project. The measurement system is currently functional and experiments are being conducted to study the correlation between the electrical noise and micro structure as well as stress in YBCO thin films. There has been recent findings which seem to suggest that the electrical noise characteristics in the normal state of YBCO films are influenced by stresses in the film. Such a correlation is of relevance to the issue of noise on HTSC radiation detectors since the devices are fabricated on substrates such as Si which are not lattice matched to YBCO and hence are known to promote significant amount of stress in the film. We are currently undertaking experiments to explore the effect of film stress on electrical noise characteristics.

2. Dopant incorporation in YBCO thin films

In collaboration with researchers at the CSR, we have been studying the effects of substituting dopants such as Fe, Co, Ni and Zn for the Cu sites in epitaxial thin films of YBCO. Dopant substituted films are of interest for the application of these materials as radiation detectors due to the following reasons: By controlled incorporation of some of the dopants such as Zn and Ni, the transition temperature can be shifted to lower values while retaining the sharpness of the transition which is necessary for good detector responsivity. This is relevant for applications of these materials as passively cooled detectors in ambients at temperatures lower than of undoped YBCO. In such a case we can lower the transition temperature to any desired value by controlling the dopant concentration at the same time retaining the sharpness of the transition. The first step in the development of such detectors would be obtaining high quality epitaxial films with controlled dopant incorporation. In collaboration with researchers at the CSR, we have been working on dopant incorporation in thin films. This work resulted in the identification of several key problems (and solutions) in obtaining controlled dopant incorporation in thin films. A major concern in the use of dopant substituted YBCO for detector applications would be the noise characteristics of such materials which would determine the detector NEP. Therefore we are also undertaking a study of the effects of dopants on electrical noise characteristics in these films to evaluate their potential detector materials.

Some of the work on dopant incorporation in YBCO films was presented at the '94 March meeting of the American Physical Society in Pittsburgh, PA. (see attachments for abstracts)

III. Course on Superconductivity at UDC

As proposed in the project, an undergraduate course on the applications of superconductivity is being offered at the Department of Electrical Engineering at UDC (see attachment for course description and course syllabus). The course which is inspired by a similar offering at MIT has been successful in eliciting interest and enthusiasm among the students in the field of applied High T_c superconductivity. Eight students were formally registered for the course and two full-time faculty members (from the Departments of Electrical Engineering and Chemistry, respectively) are currently auditing the course.

IV Future plans

1. Laboratory expansion

It is planned to expand the transport measurement system at UDC to include facilities for optical response measurements. This would require modification of the existing closed cycle helium cryostat to incorporate an optical window. We are currently investigating this option.

Also, we intend to promote the pilot laboratory at UDC to self sufficiency for noise measurement. Coupled with the transport and optical response measurements and our access to the thin film deposition and characterization facilities at the CSR, this would enable the Applied Superconductivity Laboratory at UDC to carry-out state-of-the-art research related to materials and device issues for the development of High T_c Superconductivity based radiation detectors.

2. Course offering

It is planned to continue offering the course "Introduction to Applied Superconductivity " to senior Electrical Engineering students. The course would also incorporate some "hands-on" experience through a formal laboratory session.

**Abstract Submitted
for the 1994 March Meeting of the
American Physical Society
21-25 March, 1994**

Session Title: Superconductivity ; High T_c
Materials

March Sorting
Category: 28. (a)

Electrical Noise in YBa₂Cu₃O₇ Thin Films: Correlation with Microstructure, Weak Link Effects and Inter-layer Coupling
M. RAJESWARI, J. TEFERA AND S. LAKEOU, Department of Electrical Engineering, University of District of Columbia, Washington DC, S. BHATTACHARYA, C. B. WHAN, M. REPACE, C. J. LOBB AND T. VENKATESAN, University of Maryland, College Park MD, D. D. CHOUGHULE AND S. B. OGALE, Department of Physics, University of Poona, India. We report our studies of the electrical noise in thin films of YBa₂Cu₃O₇ at the superconducting transition and in the normal state. Several studies in the past have revealed sample -dependent anomalies in the magnitude, temperature dependence, bias current dependence and frequency dependence of electrical noise at the superconducting transition. We present a systematic study of the correlation of such anomalies with the film microstructure and weak link effects. We will also discuss the role of inter-layer coupling and the effects of dopants such as Fe and Zn (which substitute for the Cu sites in the CuO₂ planes and CuO chains respectively) in the electrical noise characteristics of YBCO thin films .

Work supported by NASA Grant # NAG5- 2348

Prefer Standard Session

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**Abstract Submitted
for the 1994 March Meeting of the
American Physical Society
21-25 March, 1994**

Session Title: Superconductivity; High T_c
Magnetic Properties

**March Sorting
Category:** 28. (e)

Effects of (Co, Fe) Substitution For the CuO chain Cu sites on the Pinning Anisotropy and Inter-layer Coupling in YBCO. M.Rajeswari,* S.B.Ogale,+ S.Bhattacharya,D.D.Choughule, + M. S. Hegde,++ S. Lakeou* and T.Venkatesan. Center for Superconductivity Research, University of Maryland, College Park, MD. *Department of Electrical Engineering University of District of Columbia, Washington DC. +Department of Physics, University of Poona, India. ++Solid State and Structural Chemistry Unit, Indian Institute Of Science, Bangalore, India. We report our studies of the effect of partial substitution of the copper site in CuO chains in YBCO by Co on the anisotropic magnetic field dependence of the critical current density $J_c(B, T, \Theta)$. The $J_c(B, T, \Theta)$ in the chain-doped samples at low temperatures agrees with the Kes 2D model for $J_c(B, T, \Theta)$ as in more anisotropic systems like Bi:2212.

Work supported partly by NASA Grant # NAG5- 2348

Prefer Standard session

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UNIVERSITY OF THE DISTRICT OF COLUMBIA
COLLEGE OF PHYSICAL SCIENCE, ENGINEERING AND TECHNOLOGY

COURSE 0531- 474

INTRODUCTION TO APPLICATIONS OF SUPERCONDUCTIVITY

COURSE DESCRIPTION

0531 - 474 Introduction to Applications of Superconductivity

This course aims at imparting an introduction to the phenomenon of superconductivity with emphasis on the concepts related to the electromagnetic characteristics of the superconducting state relevant to technological applications. The course will also include a state-of-the art introduction of the materials technology and applications of novel high T_c superconductors.

Required Text : Foundations of Applied Superconductivity
- By Terry P. Orlando and Kevin A. Delin

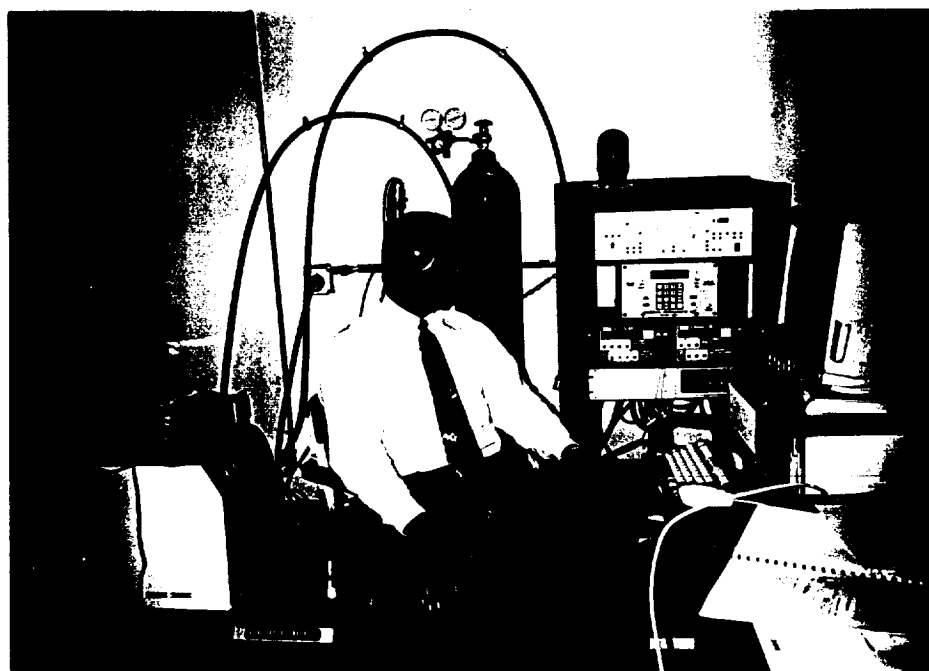
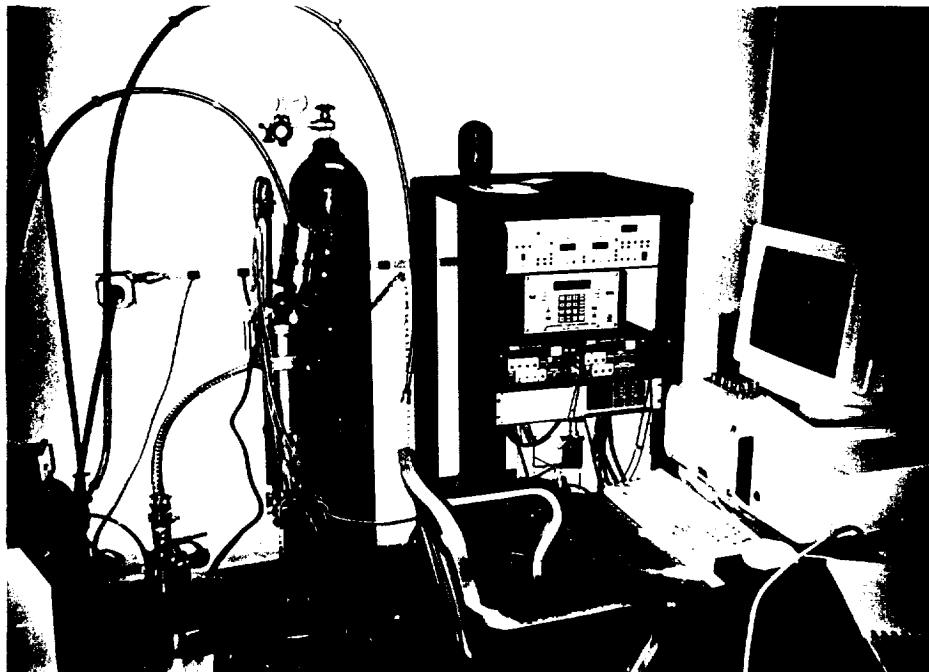
(Lecture notes will be distributed to supplement the text as and when required) .

Accreditation :

Method of Instruction : This course consists of three 1 hour sessions per week involving lectures, reviews and tests.

Method of Evaluation : There will be two tests, home-work and reading assignments , a term paper and a final examination.

Prerequisites : Permission of the Chairman,
Electrical Engineering Department



**Pictures showing the
Applied Superconductivity Laboratory at UDC**
(Bottom picture shows also Dr. S. Lakeou, PI)